

practical exercise for using PLC to control a group of sequential processes in a juice factory production line. As shown on next figs., the juice production line includes several sequential stations. 1<sup>st</sup> station is fruit selecting conveyor for sorting input fruit before next washing process in 2<sup>nd</sup> station which is a combination of conveyor, washer, absorber & drain line. 3<sup>rd</sup> station is a unit for juicing & crushing fruits and essentially for removing the seeds from the hard seed fruits. 4th station is for mixing & heating where sugar or additives or flavors, etc are added in large mixer and storage tanks. Heaters are used to accelerate mixing and to get the required juice solution. Last station is for bottling and packing the juice as per the requirement of the shape and size of the final product. Each station includes many electronics & electric devices controlled by PLC such as motors, pumps, conveyor belts. Strategic project objectives are to design & execute a program which can control production line of juice using PLC technique & simulates real system using several types of electric digital switches, Relays, LEDs & many input/output I/O devices. Furthermore, in order to practice different aspects of using PLC, the project includes also running and testing practical PLC-Simulation software to diagnose possible errors and trouble-shooting of automatic control PLC systems of sequential programming. Finally, the project includes detailed & carefully prepared documentation procedure report for both SFC, Sequential Function chart, and the LAD program



PLC controller 2.HMI 3.Inverters and electric motors for belts
 Thermocouples 5.Photoelectric sensor 6.Pushbuttons
 Inductive level sensor 8.Pressure gauges 9.Solenoid valves
 Heaters 11.Pumps 12.Spray water jet 3.Solid relay for heaters
 Software: 1.XG500

**Details of Sequential Processes:** The fruits are 1<sup>st</sup> fed manually in a conical tank to be supplied to fruit selecting conveyer to be selected visual by experts. Fruits are transferred to washer unit to be washed inside washer tank then sprayed on elevator to enter crasher & juicer unit. Fruits are pressed & rolled then juice pulp is extracted & supplied to 1<sup>st</sup> mixer to add sugar solution&heated to a specific temperature then are supplied to a 2<sup>nd</sup> mixer for heating of pasteurization & are pumped to bottling line at specific temp. As seen on 1<sup>st</sup> page, an illustrative drawing is made for production line to identify its machinery, components, and sequential operations done in production line. Then, sequential function chart is made for the juice production line to identify its sequential operations step by step, from a start point to final product passing on several steps such as sorting, washing, juicing, mixing and heating. For each operation a sub sequential function chart is made to identify the process done. Inputs, outputs & marker (or Relays in the LAD) are identified and ladder diagram is made according to desired operation of the line using ladder logic, timers, counters, special and instruction functions. The program is written on XG5000 and simulated successfully and all operations are done sequentially and efficiently.



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Sorting Process Fruit detection by	Mixing and heating	All PLC inputs, outputs and relays used in the LAD						
line P0		Inputs		Outpu	ts	Relays for tran	<mark>sition</mark>	
selecting convoyer	Juice pulp from crasher	Identifier	Address	Identifier	Address	Identifier	Address	
motor on P20		E.stop	P10	Conveyer motor on	P20	E-stop mon	M11	
Ton from From sorting line	Heater 1 on	E.stop	P11	Solenoid valve for drain	P21	Start mon	M12	
T1 Conveyer motor	P29	Estop	P12	Solenoid valve for feed water	P22	Ton for drain solenoid	T01	
Washing vessel Coper reed water		Production line start	P00	Spray water jet valve on elevator	P23	Reading of spray jet pressure	M01	
To elevator	Thermocouplesc Pump to mixer1P33 7 Flow reading	Fruit sensor at the start of line	P01	Crasher spray jet valve	P24	Desired pressure for spray jet	M03	
Spray jet on fruit	h2 Mixer motor on P28 Open sugar	Stop button for conveyer and washer	P03	Crasher motor ON	P25	Toff for delaying the stop of crasher	T04	
ValveP23	T>T defined Solution	Level induction sensor for washer NC	P02	Heater of mixer 1	P29	Desired Temp in mixer1	M06	
Pressurized tank Pressure	Pump to mixer 2	Fruit sensor before	P04	Pump to mixer 2	P27	Reading of real temp of	Ch00	
Crashing and juicing Pump on	↔ P27	crasher Pressure gauge after	P05	Inverter of mixer 1 Inverter of mixer2	P28 P30	neater1 Desired temp inside mixer	M10	
P38 P38		crasher				2		
Washed fruit from washer	T < T Heater2 on P29			Feed pump from crasher to mixer1	P33	Real reading for flow meter	C01	
Fruit sensor detector P04	Miver2 onP30			Pump for sugar solution	P34	Memory reading of flow meter	D00	
Juicer and crasher ON	Thermocouplech3			Heater of mixer 2	P31	Real temp of heater 2	Ch01	
	<b>₩</b>			Pump for pressure	P38	Desired temp of mixer2	M07	
Valve on Pressure P24 Compare Juice pulp to tank Pump P33	T> T defined			vessel		Real temp of mixer1 solution	CH02	
Pressurized tank Mixing and heating	PumpP32 to bottling and					Real temp of mixer2solution	Ch03	
Pump on P38	capping line					Desired temp of mixer 2	M60	

LAD diagram for Control of Juice Production Lin		127 P00000 P00003 P00028
P00010 EMG 1 0		
P00011 P00012	P00000 P00003 MOV M0004 M0003 46 P00000 MOV M0004 M0003 46 P00020 40 creation of the creation	r flow meter d0 desire of flow meter p34 pump for sugar solution
M00011	P00004 P00000 P00005 P00003 TOFF T0004 1800 05	- C0001 D00000 P00034
## p0 start button p1 sensor for fruit p3 stop button p20 inverter of selecting conveyor P00000 P00001 P00003 P000		
	Int #### p4 sensor of fuit _p5 pressure after crusher nt _p34 supp T0004 P00024 P00024P0	arisolution 000 P00005 P00007 P00003TON T0003 600
### m12 start from hmi p20 is internal latch for conveyor inverter P00000 P00003		
M00012	ent #### p25 inverter of crusher p24 spary water jet selonid P6 pre	ssure guage of mix 1 0003 P00029
P00020 ##### T1 timer of selonid valve	P00025 P00000 P00003 TON T0002 900 Vent 13 time	s for pump of mix2
T0001 P		0029 P00009 P00030 
		pump of mix2 presure gauage inverter of mix2 \$<02_CH1M0007 P00020 P00003 P00003
###### p21 selonid valve for drain	Sc         -02_CH0_ TEMP         M0006         P00003         P00029         lent ph i re	al temp for heater p31 heater of mix 2
F0002     F0020     F		0020 MOV M0008 M0007
P00000 P00003 P	nt p33 pump feed for water	MOV M0009 M0006
M00012	10002 P00000 P00033 etc hitor 05 P00020 rate at real	
#### p23 spray water jet	nt p27 for pump out of mix 1 p6 pressure gague of mix	Im006 for deale temp
S< M0003 M0001	P00006 P00003 S< M0010 _02_0H2 P00027 tag.	TEMP multi      D020      M0V M0025 M0011      mp is temp of solution of mix 2 m11 desire temp to out temp selonid value for out
#### m1 for real reading of pressure of jet water m3 for desire of pressure p24 pump for pressure vessil	nt p28 meter of mixer in first mix	temp of mixture when out